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I. INTRODUCTION

Research has been conducted in three general areas during this program interval. These are:

(1) the aperture admittance of a rectangular waveguide radiating into a homogeneous slab;

(2) the effect of inhomogeneous media on the aperture admittance of small aperture antennas; and

(3) development of geometrical techniques for the analysis of diffraction problems.

The following reports have been issued or are being published:

"Array Synthesis - A Least Integral Square Error Method," R. T. Compton, Jr., Report 1691-14, 20 August 1965.

"A Study of Electrodynamics Involving Moving Media," L. J. Du, Report 1691-15, 31 October 1965.

"Higher-Order Diffraction Concept Applied to Parallel-Plate Waveguide Patterns," R. C. Rudduck, J. S. Yu, Report 1691-16, 15 October 1965.

"Coupling Between Parallel-Plate Waveguides by Wedge Diffraction Techniques," L. L. Tasi, R. C. Rudduck, R. B. Dybdal, Report 1691-17, 20 October 1965.

II. WORK ACCOMPLISHED

During this program interval major effort has been placed on the analysis of the aperture admittance of a rectangular waveguide radiating into a homogeneous slab of finite thickness. A computer program has been under development to analyze the aperture admittance. Close cooperation has been maintained with NASA engineers at Langley Field in solving the problems associated with development of the analysis. At present the results which are being obtained from the program appear reasonable but an accurate check is needed. The sponsor is currently making measurements with which the results of the computer program can be checked.

For the purpose of studying the effects of inhomogeneous media on aperture admittance of antennas, two computer programs for calculating the reflection and transmission by plane waves have been used. However, it was discovered that these analyses are somewhat inadequate for relative dielectric constants less than unity, particularly for negative values. Consequently, a new computer program is being used which calculates the reflection and transmission coefficients for layered media. The program is based on an exact solution for a plane wave incident upon a medium consisting of lossy or lossless homogeneous layers for any range of dielectric values. Values of electron density and collision frequency which correspond to each layer of an inhomogeneous plasma medium may be used as input data. Transmission and reflection calculations have been made for a number of different media. However, emphasis has been placed on the electron density profile which was discussed by Swift.[1] Reflection and transmission coefficients of this medium have been calculated for both polarizations as a function of frequency and angle of incidence.

Research on various developments in the area of geometrical diffraction theory were continued. Computations of the coupling between two parallel-plate waveguides were completed. A report on the coupling analysis and computed results was completed.

In the coupling analysis two near field formulations are used for the diffraction of a line source by a wedge. Since these formulations are approximate it was desired to check their accuracy in the region where they are most approximate. An exact series solution is available which is generally impractical to compute but which can be computed in the region in which the approximate formulations need to be checked. A computer program was written to compute the exact series formulation and the approximate formulations were thus checked for accuracy. The accuracy of the approximate formulations was found to be quite good; the error is generally less than a few per cent.

Computer programs have been prepared for the analysis of the free space aperture impedance of parallel-plate waveguides. Separate programs are used for the TEM mode and the TE_{01} mode. The computations for the TEM mode have been checked for the special case of a thin-walled guide with a normal truncation angle. An exact Weiner-Hopf analysis is available for this special case for both the TEM and TE_{01} modes. The accuracy of the TEM impedance computed by edge diffraction for this special case was found to be excellent in both magnitude and phase. A computer program has been prepared to calculate the TE_{01} impedance of this special case by the Weiner-Hopf method. The accuracy of edge diffraction method for the TE_{01} mode impedance is reasonably good. In order to check the validity of the impedance calculations for guide geometries other than the above mentioned special case, a sectoral horn with parallel plates was constructed. The horn has a slotted line device attached so that the aperture reflection can be measured. This device is now being tested.

The diffraction of a non-uniform wave incident on a conducting wedge was studied. This effect is the major limitation on the use of the edge diffraction method. Some results of the influence of non-uniform illumination in the edge diffraction method were obtained for the radiation patterns of parallel-plate waveguides. Further study is needed to determine the validity of these results.

III. FUTURE PROGRAM

In the next program interval, priority will be given to the computation of the aperture admittance of a rectangular waveguide radiating into a homogeneous slab. The validity of the computer program must be checked by comparison with measured results. Also the program must be modified so that it may be used for dielectric constants less than unity.

In the study of inhomogeneous media the results obtained for the plane wave reflection will be applied to the effect on the aperture impedance of a parallel-plate waveguide. In the area of geometrical diffraction, reports are anticipated on the analyses and results of the work on the parallel-plate guide impedance and the near-field formulations. Further study is planned on the nonuniform illumination problem. It is also anticipated that a new problem will be initiated in the area of edge diffraction - most likely an analysis involving a dielectric medium or a three-dimensional geometry.

REFERENCE

1. Swift, C. T., "Radiation Patterns of a Slotted-Cylinder Antenna in the Presence of an Inhomogeneous Lossy Plasma," IEEE Trans. on Antennas and Propagation, Vol. AP-12, November 1964.